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ontario hydro
research division

To: Dr. C.F. Lee
Manager
Geotechnical and Hydraulic Engineering Department
Design and Development Division

Attn: Mr. R. Jarrett

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# CHERRYWOOD TS TO LEASIDE TS
# 230 kV TL FOUNDATION INVESTIGATION

R.H.K. Tsang

The design of steel pole foundations requires an estimate of the soil deformation modulus. A statistical analysis was performed to correlate the initial loading deformation modulus, E, from pre-bored pressuremeter tests with the N-value obtained from standard penetration tests in granular soils.

## INTRODUCTION

The statistical results of the correlation between "E" and "N" are presented. The statistical analysis using only the 1988 data base for granular material was selected. The previous data base from 1972 was omitted because the probe sizes and testing procedures were slightly different from current practices. The previous deformation modulus values (1972) appeared consistently lower in magnitude than the current testing method (Figure 1). The data base for cohesive materials was not analyzed statistically due to insufficient data at this point in time. However, similar trends are evident for "E vs N" correlations in the cohesive soil as those observed for granular soil shown in Figure 1.

## OBSERVATIONS

A statistical analysis was performed to correlate the pressuremeter modulus with standard penetration values obtained from the above tower line investigation. Several statistical models were considered on the form of linear, quadratic and square root expressions/1/. The "best fit" for the observed data was obtained with a least square linear regression (Figure 1).

ADDENDUM TO

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The linear regression equation shown in Figure 1 is as follows:

$$E = 0.5286\ N - 0.6089 \qquad (1)$$

where E - deformation modulus obtained from pressuremeter test (MPa)
N - blow count per 0.30 m from standard penetration test (blows/0.30 m)

The "goodness of fit", $r^2$ was 0.73. The 1988 data set, n, contained 49 sample points.

The regression model stated above was obtained in the following manner; three anomalous data points were eliminated from the 1988 data set in granular materials. These data points were discarded from the statistical analysis due to the following reasons:

(a) Tower No 40N (depth at 2 m)

The presence of gravel in the granular deposit might have affected the pressuremeter test results. Thus, an inconsistent modulus value was obtained for a relatively low N-value.

(b) Tower No 17N (depth at 6 m)

The possibility of hole disturbance occurred due to the presence of wet caving sands. Thus, an inconsistent modulus value was obtained for a relatively high N-value.

(c) Tower No 63S (depth at 2 m)

The presence of cobbles and/or stones might have affected the N value recorded. A low modulus value was measured by the pressuremeter test yet an inconsistently high N value was recorded.

The wide scatter in the data is typical of correlation plots of soil properties (such as deformation modulus, E) with standard penetration N-values. The following Figures 2 and 3 show the correlations between E, obtained by the pressuremeter and N-values from several site locations as reported in the literature/2,3/. A considerable amount of scatter is evident from these plots. Figures 1 to 3 thus show a trend in the data rather than a strong correlation between pressuremeter modulus and N-values. Further data is required to improve the reliability of the correlation between the deformation modulus and N-value from the standard penetration test, particularly in cohesive soils.

## CONCLUSIONS

The linear correlation obtained from the least squares linear regression (Equation 1) is recommended as a guide to select E values for the design of steel pole foundations on the Leaside to Cherrywood SS tower line.

Approved by:

T.W. Klym
Manager
Civil Research Department

Prepared by:

R.H.K. Tsang
Engineer
Soil Sciences Section

Reviewed by:

T.J. Carmichael
Supervising Engineer
Soil Sciences Section

RHKT:LM

## REFERENCES

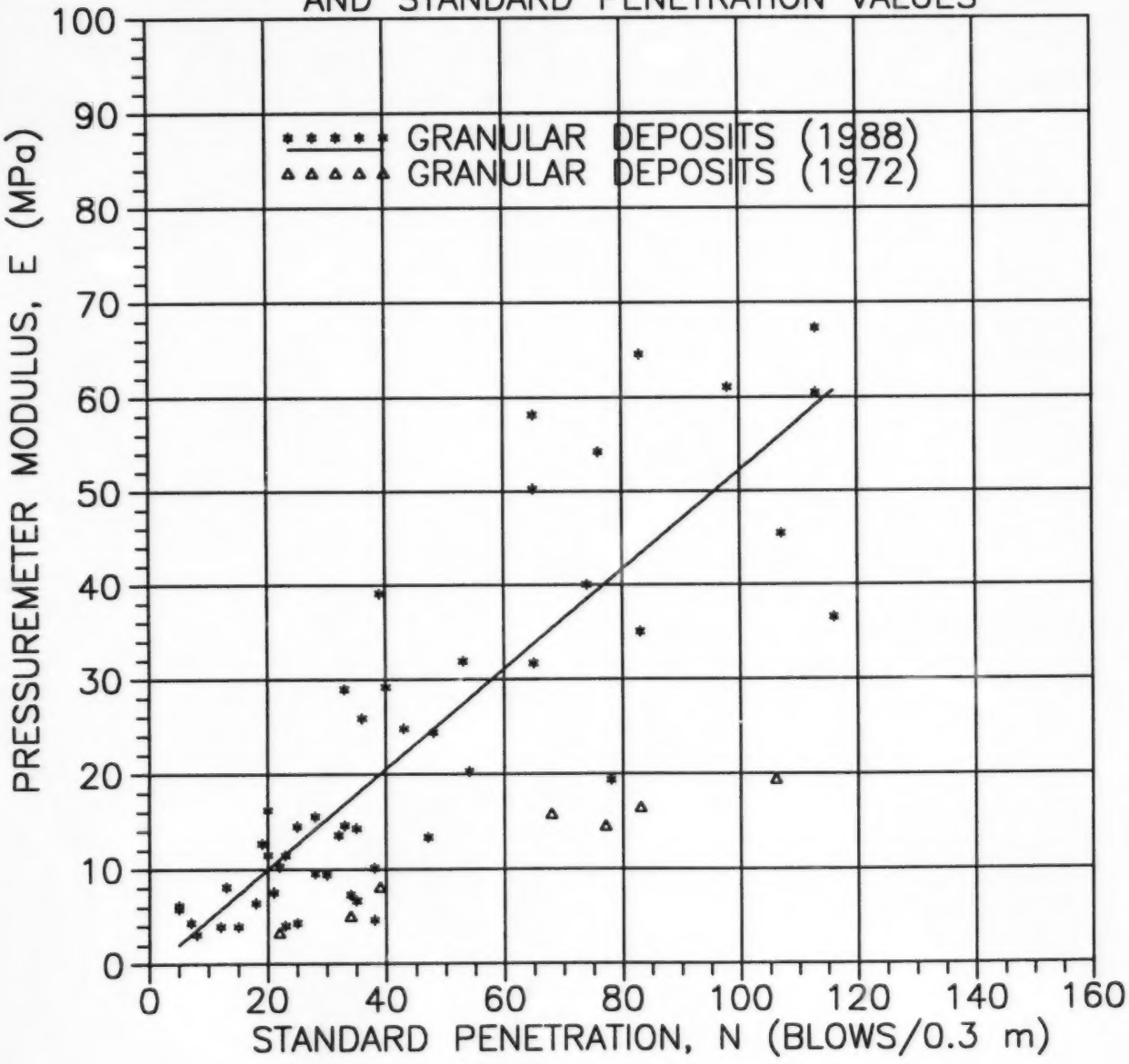

1. Camacho, F. Operations Research interoffice memo, October 24, 1988.

2. Kulhawy, F. "Manual on Estimating Soil Properties for Foundation Design". 1988 report for EPRI, in print.

3. Fukagawa, R. and Ohta, H. "Vertical Deformation Modulus of Sand Estimated by Pressuremeter Test and SPT Blow Count N". Penetration Testing 1988. ISOPT-1 Balkema, Rotterdam.

4. Radhakrishna, H.S. "Leaside TS to Cherrywood SS Proposed 230 kV - 2-cct - Steel Pole Transmission Line - Foundation Investigation". Ontario Hydro Report No 72-201-K, 1972.

FIG. 1 CORRELATION BETWEEN THE PRESSUREMETER MODULUS AND STANDARD PENETRATION VALUES




Kh = 1.67 Epmt
Kh – MODULUS OF SUBGRADE REACTION FOR A VERTICAL PLATE OF 1 m WIDTH (MN/m3)
Epmt – PRESSUREMETER MODULUS (MPa)
ASSUME POISSONS RATIO = 0.5
B = 1 m DIAMETER FOOTING
reference /4/

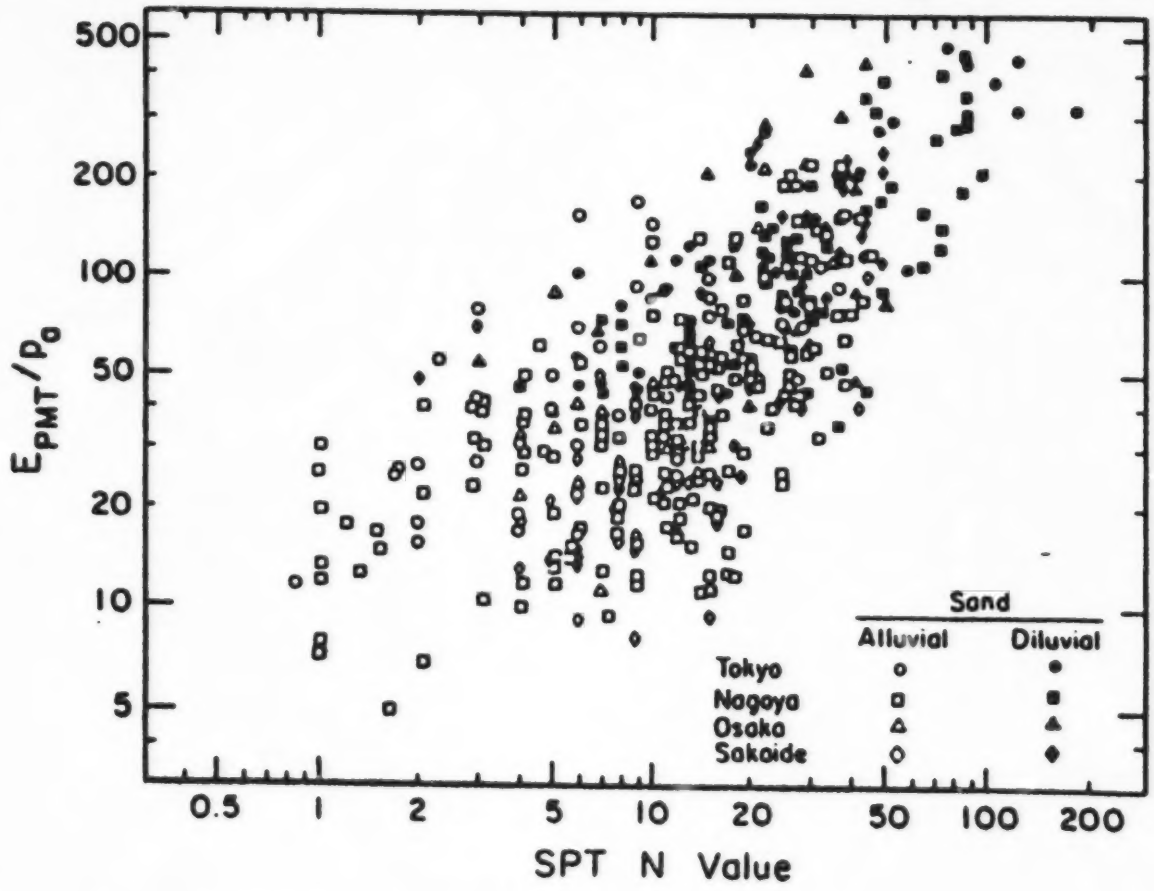



Figure 2: PMT modulus of sand versus N-value/2/

$E_{PMT}$ - pressuremeter deformation modulus (kPa)
$P_a$ - atmospheric pressure (kPa)

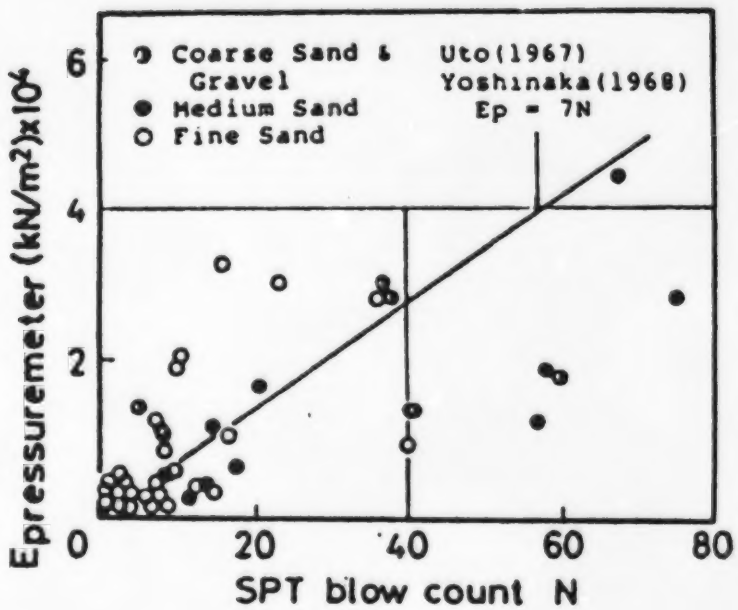



FIGURE 3: Deformation Modulus $E_{pm}$ obtained from pressuremeter tests/3/